

CLAIMS

WHAT IS CLAIMED IS:

1. An antimicrobial composition, comprising:

5 pyrithione or a pyrithione complex; and

a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and combinations thereof;

wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

2. The antimicrobial composition of claim 1, wherein said pyrithione complex is selected from the group consisting of pyrithione salts and pyrithione adducts.

3. The antimicrobial composition of claim 2, wherein said
pyrithione salt is selected from the group consisting of
sodium pyrithione, potassium pyrithione, lithium
5 pyrithione, ammonium pyrithione, zinc pyrithione, copper
pyrithione, calcium pyrithione, magnesium pyrithione,
strontium pyrithione, silver pyrithione, gold pyrithione,
manganese pyrithione, ethanolamine pyrithione salt,
chitosan pyrithione salt, disulfide pyrithione salt, and
combinations thereof.

4. The antimicrobial composition of claim 2, wherein said
pyrithione adducts are selected from the group consisting
of 2,2'-dithiopyridine-1,1'-dioxide and alkali or alkaline
15 earth complexes of 2,2'-dithiopyridine-1,1'-dioxide.

5. The antimicrobial composition of claim 1, wherein said zinc
salt is selected from the group consisting of zinc acetate,
zinc oxide, zinc carbonate, zinc chloride, zinc sulfate,
20 zinc hydroxide, zinc citrate, zinc fluoride, zinc iodide,
zinc lactate, zinc oleate, zinc oxalate, zinc phosphate,
zinc propionate, zinc salicylate, zinc selenate, zinc
silicate, zinc stearate, zinc sulfide, zinc tannate, zinc

tartrate, zinc valerate, zinc gluconate, zinc undecylate,
and combinations thereof.

6. The antimicrobial composition of claim 1, wherein said
5 copper salt is selected from the group consisting of copper
disodium citrate, copper triethanolamine, copper carbonate,
cuprous ammonium carbonate, cupric hydroxide, copper
chloride, cupric chloride, copper ethylenediamine complex,
copper oxychloride, copper oxychloride sulfate, cuprous
10 oxide, copper thiocyanate, and combinations thereof.

7. The antimicrobial composition of claim 1, wherein said
silver salt is selected from the group consisting of silver
bromide, silver chloride, silver citrate, silver iodide,
15 silver lactate, silver nitrate, silver oxide, silver
picrate, and combinations thereof.

8. The antimicrobial composition of claim 1, wherein said zinc
or copper or silver complex comprises zinc or copper or
20 silver in combination with a complexing agent.

9. The antimicrobial composition of claim 8, wherein said
complexing agent is selected from the group consisting of

zeolites, titania, carbon, azoles, EDTA, EGTA, crown
ethers, cryptates, cyclodextrin, and combinations thereof.

10. The antimicrobial composition of claim 1, wherein said zinc
or copper or silver source is generated electrolytically.

11. The antimicrobial composition of claim 1, wherein said
weight ratio of said zinc or copper or silver source to
said pyrithione or said pyrithione complex is in the range
of from about 1:100 to about 1:1.

12. A method of inhibiting the growth of microorganisms
selected from the group consisting of free-living
microorganisms, parasitic microorganisms, adherent
microorganisms, biofilms, and combinations thereof,
comprising the step of contacting said microorganisms with
an antimicrobial composition comprising pyrithione or a
pyrithione complex; and a zinc or copper or silver source
selected from the group consisting of zinc or copper or
silver salts, zinc or copper or silver oxides, zinc or
copper or silver hydroxides, zinc or copper or silver
sulfates, zinc or copper or silver chlorides, zinc or
copper or silver metals, zinc or copper or silver
complexes, and combinations thereof; wherein the weight

ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against said microorganisms.

13. The method of claim 12, wherein said pyrithione complex is selected from the group consisting of pyrithione salts and adducts of pyrithione.

14. The method of claim 13, wherein said pyrithione salt is selected from the group consisting of sodium pyrithione, potassium pyrithione, lithium pyrithione, ammonium pyrithione, zinc pyrithione, copper pyrithione, calcium pyrithione, magnesium pyrithione, strontium pyrithione, silver pyrithione, gold pyrithione, manganese pyrithione, ethanolamine pyrithione salt, chitosan pyrithione salt, disulfide pyrithione salt, and combinations thereof.

15. The method of claim 13, wherein said pyrithione adducts are selected from the group consisting of 2,2'-dithiopyridine-1,1'-dioxide and alkali or alkaline earth complexes of 2,2'-dithiopyridine-1,1'-dioxide.

16. The method of claim 12, wherein said zinc salt is selected from the group consisting of zinc acetate, zinc oxide, zinc carbonate, zinc chloride, zinc sulfate, zinc hydroxide, zinc citrate, zinc fluoride, zinc iodide, zinc lactate, zinc oleate, zinc oxalate, zinc phosphate, zinc propionate, zinc salicylate, zinc selenate, zinc silicate, zinc stearate, zinc sulfide, zinc tannate, zinc tartrate, zinc valerate, zinc gluconate, zinc undecylate, and combinations thereof.

17. The method of claim 12, wherein said copper salt is selected from the group consisting of copper disodium citrate, copper triethanolamine, copper carbonate, cuprous ammonium carbonate, cupric hydroxide, copper chloride, cupric chloride, copper ethylenediamine complex, copper oxychloride, copper oxychloride sulfate, cuprous oxide, copper thiocyanate, and combinations thereof.

18. The method of claim 12, wherein said silver salt is selected from the group consisting of silver bromide, silver chloride, silver citrate, silver iodide, silver lactate, silver nitrate, silver oxide, silver picrate, and combinations thereof.

19. The method of claim 12, wherein said zinc or copper or silver complex comprises zinc or copper or silver in combination with a complexing agent.

5 20. The method of claim 19, wherein said complexing agent is selected from the group consisting of zeolites, titania, carbon, azoles, EDTA, EGTA, crown ethers, cryptates, cyclodextrin, and combinations thereof.

10 21. The method of claim 12, wherein said zinc or copper or silver source is generated electrolytically.

15 22. The method of claim 12, wherein said weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range of from about 1:100 to about 1:1.

20 23. The method of claim 12, wherein said microorganisms are selected from the group consisting of *Pseudomonas aeruginosa*, *Aspergillus niger*, *Fusarium*, *Cephalosporium*, *Pseudomonas fluorescens*, *Pseudomonas rubescens*, *Pseudomonas stutzeri*, *Pseudomonas oleovorans*, *Alcaligenes faecalis*, *Citrobacter freundii*, *Escherichia coli*, *Staphylococcus*

aureus, *Candida albicans*, *Pityrosporum ovale*, and combinations thereof.

24. A fuel, fluid, or lubricant, comprising water or an organic
base fluid and an antimicrobial composition, said
antimicrobial composition comprising pyrithione or a
pyrithione complex; and a zinc or copper or silver source
selected from the group consisting of zinc or copper or
silver salts, zinc or copper or silver oxides, zinc or
copper or silver hydroxides, zinc or copper or silver
sulfates, zinc or copper or silver chlorides, zinc or
copper or silver metals, zinc or copper or silver
complexes, and combinations thereof; wherein the weight
ratio of said zinc or copper or silver source to said
pyrithione or said pyrithione complex is in the range from
about 1:300 to about 50:1, and wherein said antimicrobial
composition has an enhanced biocidal effect against
microorganisms selected from the group consisting of free-
living microorganisms, parasitic microorganisms, adherent
microorganisms, biofilms, and combinations thereof.

25. The fuel, fluid, or lubricant of claim 24, wherein said
weight ratio of said zinc or copper or silver source to

said pyrithione or said pyrithione complex is in the range of from about 1:100 to about 1:1.

26. The fuel, fluid, or lubricant of claim 24, further comprising a component selected from the group consisting of corrosion inhibitors, surfactants, and combinations thereof.

27. A coated substrate comprising a substrate together with a coating on said substrate, said coating being produced by:

(a) contacting said substrate with a coating composition comprising pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver metals, zinc, or copper, or silver complexes, and combinations thereof; wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group

consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof; and

(b) drying said coating composition on said substrate to produce said coated substrate.

28. The coated substrate made by the method of claim 27.

29. The coated substrate of claim 27, wherein said weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range of from about 1:100 to about 1:1.

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30. A coating composition, comprising:

(a) a base medium comprising water or a solvent resin system selected from the group consisting of vinyl, alkyd, epoxy, acrylic, polyurethane and polyester resins, and combinations thereof; and

(b) a biocide comprising an antimicrobial composition consisting essentially of pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc

or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and combinations thereof; wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

31. The coating composition of claim 30, wherein said weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range of from about 1:100 to about 10:1.

32. A composition comprising a plastic or a woven or non-woven fiber, or a textile which comprises, in combination, a plastic or a fiber and an antimicrobial composition consisting essentially of pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc

or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and combinations thereof; wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

33. An antimicrobial composition for treating microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof, comprising:

a salt of pyrithione; and

a zinc metal salt;

wherein the weight ratio of said water-soluble zinc metal salt to said salt of pyrithione is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-

living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

34. The antimicrobial composition of claim 33, wherein said salt of pyrithione is sodium pyrithione and said zinc metal salt is selected from the group consisting of zinc chloride, zinc oxide, zinc sulfate, and combinations thereof.

35. An adhesive composition, comprising:

- (a) an adhesive base medium; and
- (b) a biocide comprising an antimicrobial composition consisting essentially of pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and combinations thereof; wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected

from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

5 36. ✓ An elastomer composition, comprising:

(a) an elastomeric base medium; and

10 (b) a biocide comprising an antimicrobial composition consisting essentially of pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and
15 combinations thereof; wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected
20 from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

37. A sealant composition, comprising:

(a) a sealant base medium; and
(b) a biocide comprising an antimicrobial composition consisting essentially of pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and combinations thereof; wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

38. A skin care composition, comprising:

(a) a skin care base; and
(b) a biocide comprising an antimicrobial composition consisting essentially of pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver

salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and combinations thereof; wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

39. A method of preserving cellulose-based material, comprising the steps of:

contacting a cellulose-based material with an antimicrobial composition, comprising pyrithione or a pyrithione complex; and a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver

metals, zinc or copper or silver complexes, and combinations thereof;

wherein the weight ratio of said zinc or copper or silver source to said pyrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

40. The method of claim 39, wherein said cellulose-based material is selected from the group consisting of wood, paper, cardboard, and combinations thereof.

41. A method of preserving detergents or surfactants, comprising the steps of:
contacting a detergent or surfactant with an antimicrobial composition, comprising:
pyrithione or a pyrithione complex; and
a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or

silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver metals, zinc or copper or silver complexes, and combinations thereof;

5 wherein the weight ratio of said zinc or copper or silver source to said pyrrithione or said pyrrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.

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15 42. A pharmaceutical composition, comprising:

- (a) a pharmaceutically acceptable carrier; and
- (b) an antimicrobial composition, comprising pyrrithione or a pyrrithione complex; and

20 a zinc or copper or silver source selected from the group consisting of zinc or copper or silver salts, zinc or copper or silver oxides, zinc or copper or silver hydroxides, zinc or copper or silver sulfates, zinc or copper or silver chlorides, zinc or copper or silver

metals, zinc or copper or silver complexes, and combinations thereof;

wherein the weight ratio of said zinc or copper or silver source to said pyrrithione or said pyrithione complex is in the range from about 1:300 to about 50:1, and wherein said antimicrobial composition has an enhanced biocidal effect against microorganisms selected from the group consisting of free-living microorganisms, parasitic microorganisms, adherent microorganisms, biofilms, and combinations thereof.